IN THE SPECIFICATION:

Page 2, paragraph 2 (lines 16-28):

B1

According to another known type of tire sensing device, a number of toroidal bands of piezoresistive or piezoelectric material are disposed in the tread of the tire. Notably, the measurement obtained by this device is not localized to a single tread block, and as a result, suffers from undesirable effects due to centrifugal force, road surface irregularities, and pressure changes. In yet another sensor device for monitoring tires, reed sensors incorporating strain gauges are employed, each sensor measuring forces directed in a single axis. In this arrangement, three separate devices, disposed at three separate locations, are required to obtain three axes of traction data. A significant problem associated with such a device is that each individual tread block will experience forces from the three axes concurrently. Typically, each tread block acts independently in a stick-slip fashion. As a result, measuring X axis data from one tread block, Y axis data from an adjacent tread block and Z axis data from yet another location, will yield three axes of data that is of little use.

Page 8, paragraph 3, lines 21-26:

B2

Using sensor assembly 20 to obtain a measure of both the shear force in the X direction and the shear force in the Y direction, as described above, a compressive force along the Z-axis can be determined. In particular, the compressive force in the Z direction is equal to the sum of the tensile strains measured by sensors 22, 24, 30, and 32. In this way, a separate sensor arrangement for measuring compressive force is not required.

Page 12, paragraph 3, lines 28-29 bridging page 13, lines 1-15:

B3

In Figure 8, the components of a sensor assembly 40' are shown arranged according to a preferred embodiment. Sensor assembly 40' includes a flexible pyramid-shaped body or insert 70 that is bonded to a surface 74 of a substrate 76 of a flexible printed circuit 72, preferably with an adhesive 77. Printed circuit 72 is fabricated with

B3
Conc.

electrical conductors disposed in an epoxy or polyimide substrate 76, while strain sensors 22, 24 (which measure shear strain in a first direction, for example, the x direction) are electrically attached to flexible printed circuit 72 via a connection 78. Moreover, sensors 22, 24 are bonded to surfaces 80, 82, respectively, of flexible pyramid-shaped body 70, preferably by an adhesive such as an epoxy 71. Similar connections are made for a second pair of sensors (not shown) that measure strain forces in a second direction orthogonal to the first direction, for example, the y direction as shown in Figure 4. Alternatively, substrate 76 could be a silicon integrated circuit (IC) fabricated in conventional fashion. The entire sensor assembly 40' may optionally be potted or coated in a material 84 such as an epoxy or some other material suitable to the user, for example, to scale the strain forces exerted on sensors 22, 24, as discussed in further detail below in conjunction with one preferred application of the present invention.

Page 13, paragraph 3, lines 29-31 bridging page 14, lines 1-7:

B4

Referring next to Figure 10, as suggested previously, a preferred application of the sensor of the present invention is in a tire monitoring environment. Figure 10 illustrates a cross sectional view of tread rubber portion 112 of a tire 110. A tread block 114 is shown having a device 116 including sensor assembly (for example, 40 in Figure 5) embedded therein. Notably, device 116 is shown as a square and is oriented to indicate the portion of tread block 114 that is represented in the strain diagrams of Figures 2 and 3. Preferably, device 116 is located in a tread block at or near the center portion of the cross-section of the tire so as to ensure the device measures forces acting in the contact region of the tire.

Page 15, paragraph 1, lines 1-12:

B5

Notably, the operating range of the sensor must be considered in the manufacturing process. The tread rubber in the position to be measured will experience a maximum shear strain of about 10%, or 100,000 micro strains. Taking a typical foil type resistive strain gauge for example, fatigue and failure will occur if the gauge is repeatedly overstrained. At 1500 micro strain, the gauge will fail after about a million cycles, which

B5 conc.

would occur in about a thousand miles in a tire. At 1200 micro strain, the gauge will last approximately 100,000 miles. Generally, the amount of strain experienced by a device embedded within another material is related to the ratio of the elastic modulus of the materials. Tread rubber has a modulus of elasticity of about 3-7 Mega Pascals. The foil gauge is preferably encapsulated in polyimide or epoxy (as shown, for example, in Figure 8 at 83) which has a modulus of elasticity of about 3-7 Giga Pascals, thus providing a scale factor of about 1000.

Page 15, paragraph 2, lines 13-22:

B6

Overall, the amount of strain incurred by the sensor assembly including metal resistor strain gauges can be scaled by one or more of the three following components: the dimensions or composition of the pyramid-shaped body (for example, 42 in Figure 5), the strain gauge encapsulation, or the adhesive or potting material. Alternatively, or in combination with one or more of these components, a topping or coating layer (*e.g.*, 85 in Figure 8) may be added to further scale the strain exerted on the sensor. The topping, for example, may be brass. In the case where the strain sensor is not a metal resistor, these components, including the topping layer, may still be used to scale the strain at the sensor, however, other types of sensors, such as some of those described above, may not incorporate encapsulation.

Page 16, paragraph 2, lines 7-24:

B7

Moreover, encapsulation, adhesive, and potting may comprise three different materials, or may be reduced to one or two unique materials, thereby combining their form and functions. First, metal foil type strain gauges 22, 24, 30, 32 are often provided with epoxy or polyimide encapsulation. Next, the sensor must be adhered to the pyramid-shaped body by some means. Adhesion between the components of the device is vital for its survival. The components may be of different materials with different elastic properties. The adhesive must bond these components and withstand billions of strain cycles without failure. Some materials which meet these requirements include epoxy, polyimide and polyurethane. Epoxy is the preferred adhesive because of its

B7 Conc.

ability to adhere well and remain temperature resistant. The adhesive is preferably applied as a thin layer between components, such as between the body and the sensors. Otherwise, in addition to the thin layer of adhesive between components, an excess may be applied, such that the assembly is potted, partially or entirely, with the adhesive to insure a uniform and controllable outer surface (84 in Figure 8, for example). Alternatively, two different materials may be used for adhesion between components and for potting, respectively. Notably, however, the outermost surface (e.g., the potting) of the three-axis device should be of a material that is compatible with the embedding and curing process.

Page 17, paragraph 3, lines 14-20:

B8

PZT (lead zirconium titanate) sensors, schematic shown in Figure 1C, can be used in place of resistive strain gauges in order to save power. PZT is brittle yet highly sensitive. To bring the strain into the range of these devices, the pyramid-shaped body is made of a relatively hard epoxy, and the sensors is preferably encapsulated in the same epoxy. In one arrangement, the device could be assembled from four individual piezo crystals. Otherwise, PZT could be deposited on the body itself, or on a substrate to be formed into a pyramid-shaped body.

Page 17, paragraph 4, lines 21-29:

B9

In Figure 11, multiple devices 116 (Figure 10) including sensor assemblies (for example, 40 in Figure 5) are distributed around the circumference of tire 110. Any number of sensor assemblies may be employed. Preferably, the sensors are separated sufficiently along the circumference such that only one sensor is allowed to pass through the tire's contact region at any particular time. Notably, an increase in the number of sensor assemblies will decrease the sensitivity of any one sensor assemblies if they are summed or averaged together as in the case with any of the sensor busses described hereinafter. The preferred number of sensors is between 3 and 10.